Improving Students' Problem Solving Skills in Learning with Problem Based Learning Integrated Predict, Observe Explain Model on Global Warming Material

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Abstract. In the following study, the aim is to analyze the improvement of students' problem solving skills in learning activities with problem-based learning models integrated with predict, observe, explain models, especially for global warming material. The study was conducted using quantitative methods with 33 participants of class X students at one of the SMAN Cimahi City which was determined based on convenience sampling technique. The data collected in the following study was conducted through a problem solving skills test instrument in the form of pretest and posttest questions. To analyze the data obtained, using N-Gain testing on the data from the pretest and posttest scores. The results showed that each aspect of problem solving skills experienced a moderate increase. In addition, the acquisition of hypothesis testing proves that there is a difference in the application of the PBL-POE model in improving students' problem solving skills.

Keywords: global warming, problem solving skills, problem based learning

1. Introduction

Problem solving skills can be said to be skills in which the process requires logic in finding various solutions to the problems being faced [1]. Aspects of problem solving skills consist of (1) understanding the problem with an indicator of writing and analyzing the data contained in the problem, (2) planning problem solving with an indicator of being able to determine how to solve the problem, (3) carrying out the problem solving design with an indicator of carrying out the design according to what has been made before, finally (4) re-examining the solution made with an indicator of reviewing the solution made, if there is another solution [2]. Problem solving ability is also called a process that is carried out in a planned manner to get a solution to a problem with several possible solutions that cannot be obtained quickly [3]. So if students are often given training to solve problems, their ability to get information according to facts in the field, analyze the information obtained and re-examine the information obtained to solve the problem will be better [4].

In physics subjects which include a process of interaction between teaching and learning activities with the surrounding environment to obtain knowledge, concepts, and facts about objects in nature logically, and often encountered problems that must be solved by students so that it requires problem solving skills in it. In a learning with a problem-solving process basically uses the thinking process in solving a difficulty that arises and collects facts related to these difficulties to get alternatives in solving these difficulties [5].

However, the conditions found in most students are that they are not used to solving problems due to various factors. For example, the learning model used is not very appropriate until students assume that a subject, especially physics, is a difficult subject, causing students to feel difficult even before trying to solve the problems given. Then according to the acquisition of a study conducted by PISA [6] provides evidence that the problem-solving skills possessed by students in the aspect of using knowledge

and how to identify problems to be able to understand existing facts and decision making in solving a problem is still low in Indonesia. So that a learning model is needed to provide an increase in the critical attitude of students so that the learning and teaching process becomes more interactive.

Not only that, the curriculum currently used is also different from the previous curriculum, namely "Kurikulum Merdeka". Based on the learning principles of the curriculum, the learning process must support the development of learners' competencies and characters holistically, meaning that in the learning process educators are encouraged to use a variety of methods to develop learners' competencies, including inquiry-based, project-based, problem-based, and differentiated learning [7]. This can be overcome one of them by using a problem-based learning (PBL) model which has a problem-solving basis in which there is a combination of communication between educators and students or students with students so that learning activities can be centered on students [8].

The advantage of the problem-based learning model is that this model can encourage students in the process of solving problems independently or in groups so that the problems given can be answered with the support of their knowledge [9]. Then, the use of problem-based learning models is quite good in helping students understand the material provided because there is a relevant problem-solving process [10]. Not only that, another advantage of the problem-based learning model is that this learning model can help students to gain new knowledge by using the problem-solving process and can be applied to everyday life [11].

Besides the problem-based learning model, there is also the predict, observe, explain (POE) model in the learning process. Predict, Observe, Explain (POE) is one of the models that also involves a lot of students so that learning is not centered on the teacher. This model can show the ability of students to make predictions to answer the problems given and collect data to solve these problems which then the data will be compared with the initial predictions to be presented in class [12]. In addition, Annam, et al also revealed that the predict, observe, explain model has advantages such as students can clearly express how their initial thoughts are, making students more motivated in exploring the problem solving process.

Therefore, in accordance with what has been described, to optimize the improvement of students' problem-solving skills, researchers will combine the PBL model with the predict, observe, explain (POE) model to be applied in the teaching and learning process. This is because the use of the predict, observe, explain model can support the implementation of problem-based learning, including, students can be better trained in predicting the answers to the problems given and proving at the end of learning by previously carrying out the investigation process. So this research aims to apply the Problem Based Learning model integrated with the Predict, Observe, Explain model to improve students' problem solving skills. It is hoped that by integrating these two models, there will be an increase in students' problem solving skills so that students can solve the problems faced, especially in global warming material in a planned manner and in accordance with the solution of the facts obtained.

2. Method

This research uses a quantitative approach. The sample of this research were 33 participants of class X students at one of the SMAN Cimahi City which determined based on convenience sampling. Convenience sampling is a sampling technique that is taken according to the needs and convenience of the research with the sample can be generalized from the existing population [13]. For more details, it is presented in Table 1 below.

Table 1. Research method.

Pretest	Treatment	Posttest
O_1	X	O_2

Where O_1 as Pretest, O_2 as Posttest and X as Class treatment, teaching and learning activities that use the problem-based learning model integrated predict, observe and explain.
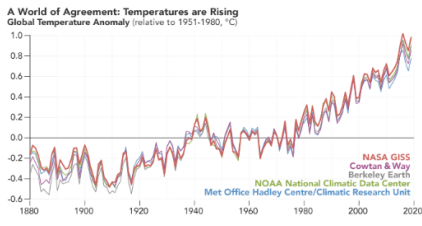
This research was held in two meetings in which the problem-based learning integrated with predict, observe, explain model was applied to each sub-material presented in Table 2.

Table 2. PBL-POE syntax in learning material/activities.

Syntax	Material/Learning Activities	
	First Meeting	Second Meeting
PBL : Problem Orientation to Students	Given a visualization related to global warming facts and the amount of CO_2 in the atmosphere	Gives examples of pictures of human activities that cause global warming and solutions to prevent global warming
PBL : Organizing students for Problem Research POE : Predict	Students sit in groups and complete worksheets related to the facts and impacts of global warming	Students sit in groups and complete worksheets related to human activities that cause global warming and solutions to prevent global warming
PBL : Assist Students in Investigation POE : Observe	Students look for solutions to the problems given in the worksheet	Students look for solutions to the problems given in the worksheet
PBL : Develop and Present Results POE : Explain	Students present their findings related to their worksheet on global warming facts and impacts	Students present their findings related to their worksheet on global warming facts and impacts
PBL : Analyzing and Evaluating the Process of Solving Problems	Students discuss with each other if there are different solutions	Students discuss with each other if there are different solutions

Students first filled out a pretest sheet before being given treatment and then saw the final results by analyzing posttest data after treatment. Data were collected by giving pretest and posttest using problem solving skill test instrument. The instruments consisted of five questions, each question consisting of four sub-problems that based on the aspects and indicators [2]. The following Table 3 is an example of one of the pretest and posttest questions based on the aspects and indicators.

Table 3. Aspects, indicators and question of problem solving skills.

Aspects of Problem Solving Skills	Indicators	Question
Problem		The following graph is the result of annual global temperature observations from 1880 to 2020 by several international research organizations. a. What can you interpret from the graph?
Understand the problem	Analyzing the data obtained with language and sentences that are easy to understand based on understanding	
Planning Problem Solving	Can search for the necessary things before solving the problem	b. Why is rising temperature associated with global warming?

Aspects of Problem Solving Skills	Indicators	Question
Implementing the Problem Solving Plan	Carry out the plan according to what has been made before	c. What can you do to prevent the temperature from rising each year?
Rechecking the Solution	Review the solution, in case there is a more appropriate solution	d. What can you do to prevent the temperature from rising each year?

After that, the results of the pretest and posttest will be analyzed using the N-Gain test. After calculating the score obtained by students, the N-gain value will be calculated with the following equations and categories below [14].

$$N - Gain = \frac{posttest\ score - pretest\ score}{maximum\ score - pretest\ score} \times 100\% \qquad (1)$$

Table 4. N-Gain value category.

N-Gain value <g>	Category
g < 0.3	Low
0.3 ≤ g ≤ 0.7	Medium
g > 0.7	High

3.   Result and Discussion

In the first meeting, students will be directed to fill out a *pretest* sheet after which they are given material on the definition and facts of global warming and the increase in CO_2 levels in the atmosphere that causes global warming. After that students are given material on human activities that cause global warming and solutions to prevent global warming, finally students are asked to fill out a *posttest* sheet. The following is one of the learning activities carried out during the research presented in Figure 1.

Figure 1. Learning activities.

Next will be presented details of data on the improvement of students' problem solving skills in each aspect. Understanding the problem, planning problem solving, implementing the problem solving plan, and rechecking the solution.

3.1.   *Aspects of Understanding the Problem*

In the aspect of understanding the problem, students are asked to be able to analyze the problem by writing down the known data in the problem that has been presented. The following is data on the improvement of aspects of understanding the problem based on the overall pretest and posttest results presented in Table 5.

Table 5. N-gain category of understanding the problem.

	Mean	$\langle g \rangle$	Category
Pretest	2,0		
Posttest	2,6	0,3	Medium

Based on Table 5, it can be seen that there is an increase in pretest and posttest scores on items with aspects of understanding the problem. The following graph is presented in Figure 2 to see more clearly the increase in the aspect of understanding the problem based on the pretest and posttest scores.
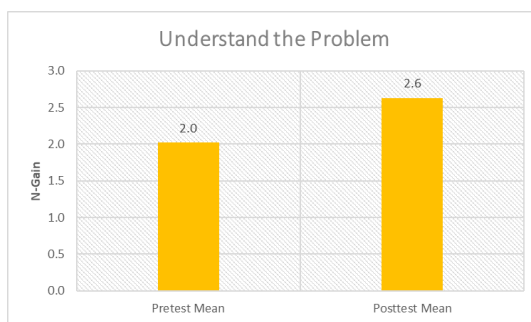

Figure 2. Comparison chart of n-gain value of understand the problem between pretest and posttest score.

Based on Figure 2 and Table 5 above, the increase in the aspect of understanding the problem of students get a medium category. This aspect gets a gain value of 0.3 and there is an increase between the *pretest* and *posttest* in the medium category. This can be caused because there are still some students who have not been able to analyze and write down the data in the problem and only briefly rewrite the existing data without the results of their analysis. But still experienced an overall increase. There was an increase in the aspect of understanding the problem in the learning carried out [15]. The research using two cycles which proved an increase in the aspect of understanding problems from cycle I to cycle II [15]. It was also found in a previous study that the aspect of understanding the problem of students getting a greater value in the class that was given treatment than the class that was not given treatment [16].

3.2. *Aspects of Planning Problem Solving*
In the aspect of planning problem solving, students are asked to be able to determine ways or strategies to solve the problems presented. The following is data on the improvement of aspects of planning problem solving based on pretest and posttest results in Table 6.

Table 6. N-gain category of planning problem solving.

	Mean	$\langle g \rangle$	Category
Pretest	1,7		
Posttest	2,8	0,5	Medium

Based on these data on Table 6, the aspect of planning problem solving increased in the moderate category. The comparison between the pretest at meeting 1 and the posttest at meeting 2 in the form of a graph can be seen in the details of Figure 3 as follows.

From the data presented in Table 6 and Figure 3 above, it can be seen that the N-gain value obtained is 0.5 which is categorized as medium. This can be caused because in this aspect there are students who are still inaccurate and incomplete in deciding how to or the right strategy to solve the problem so that it has an impact on the next aspect which is implementing the problem solving plan. Even so, overall there is an increase in posttest scores compared to pretest in this aspect. The following results are similar to previous studies which conveyed that there was an increase in the aspect of planning problem solving as seen from the percentage of this aspect increasing at the end of cycle II [17]. Similar findings were

presented the research which showed that the aspect of planning problem solving experienced a significant increase at the end of cycle II (18).
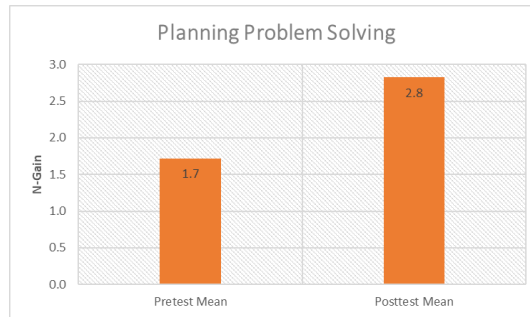

Figure 3. Comparison chart of N-gain value mean of planning problem solving between pretest and posttest score.

3.3.   *Aspects of Implementing the Problem Solving Plan*
The aspect of implementing this problem solving plan requires students to be able to carry out the plan according to what has been made previously to solve the problem. The following is Table 7 which contains data processing results on aspects of understanding problems based on pretest and posttest results.

Table 7. N-gain Category of Implementing the Problem Solving Plan

	Mean	<g>	Category
Pretest	1,8	0,4	Medium
Posttest	2,7		

Furthermore, based on this data, a graph will be presented in Figure 4 below which shows the improvement in the ability of students in the aspect of implementing the problem solving plan.
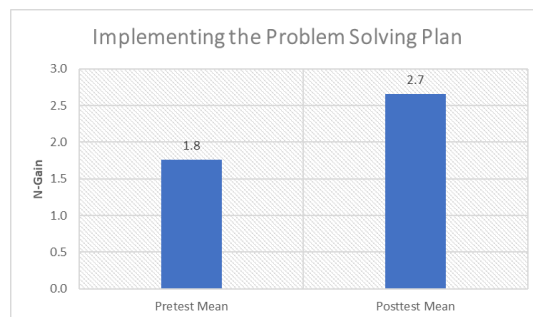

Figure 4. Comparison chart of N-Gain value mean of implementing the problem solving plan between pretest and posttest score.

The results shown in Table 7 and Figure 4 show that the N-gain value obtained in the aspect of implementing the problem solving plan is 0.4 and has a medium increase. Because like the previous aspects, there are still answers from students who have not fulfilled this aspect. Based on students' answers, there are still answers that deviate so that they are not in accordance with the plans that have been made. Nevertheless, the aspect of implementing the problem solving plan has increased overall. A similar thing was found by Dhema & Jufriansyah in the research he had conducted [19]. In their research, they found that the aspect of implementing the problem solving plan on the *posttest* score had increased and was in good qualification [19]. As also found in another research that the aspect of implementing a problem solving plan has increased at the end of learning [17].

3.4. *Aspect of Rechecking the Solution*

In the last aspect, rechecking the solution, students are asked to be able to review existing solutions if there are other solutions that are more appropriate in solving problems. The following is Table 8 containing the N-gain results and their categories.

Table 8. N-gain Category of Rechecking the Solution.

	Mean	<g>	Category
Pretest	1,5	0,3	Medium
Posttest	2,2		

Then a comparison is shown in the form of a graph in Figure 5 below which is a graph of improvement in the aspect of rechecking the solution.
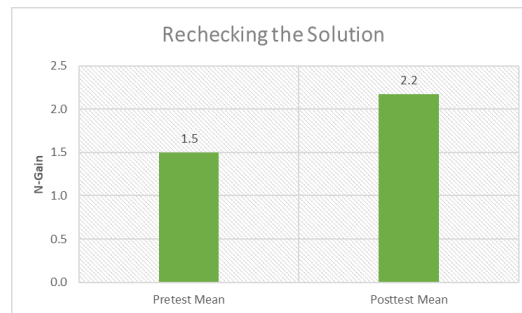

Figure 5. Comparison chart of N-Gain value mean of rechecking the solution between pretest and posttest score.

The data obtained in Table 8 and Figure 5 previously shows the gain value obtained is 0.3 and has increased in the pretest value compared to the posttest in the medium category. Because in this aspect there are still students who have not fully restated the solution and some students only rewrite the answers that have been given in the problem with the aspect of implementing the problem solving plan. But overall this aspect continues to increase. A similar thing was stated in another research that the aspect of re-examining the solution made increased in value at the end of cycle II in each item given in the lesson [18]. Then in other research, Vera also found that the aspect of re-examining the solution made experienced a considerable increase in the posttest compared to the pretest [20].

3.5. *Overall Improvement of Problem Solving Skills*

When viewed as a whole, the problem solving skills of students in learning activities with the use of problem based learning models integrated into the predict, observe, explain model have increased even though they are in the medium category as a whole and in each aspect as presented in Figure 6 which presents the following bar chart.
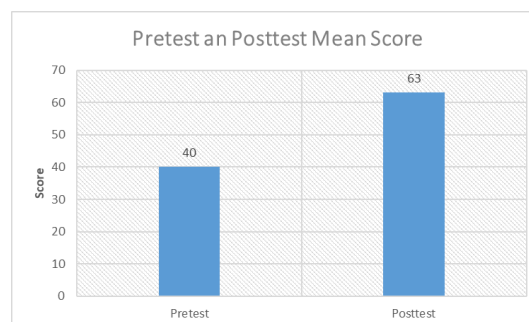

Figure 6. Comparison chart of pretest posttest score mean of problem solving skills.

This overall has similar results to the study that has been carried out by Fitriani, which results in the problem-based learning model integrated with predict, observe, explain getting a good response from

students and can even play a role in improving students' problem solving skills [21]. In addition, Fitriani stated in the results of her research that the use of a problem-based learning model integrated with predict, observe, explain is practical and effective in its use so that it can be recommended as a model that can develop students' problem solving skills [22]. Similarly, in previously conducted research, found that the use of this model applied to teaching and learning activities was effective in improving students' skills [23].

4.   Conclusion
Based on the results of the study, the increase in students' problem solving skills with teaching and learning activities in which the problem-based learning model is integrated with predict, observe, explain is included in the medium category. Therefore, this model is effective in improving students' problem solving skills, especially in learning physics on global warming material. This model can also be a recommendation in physics learning and other learning with different materials.

Acknowledgement

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